ANNUAL ADMINISTRATIVE REPORT (FY2001) AND WORK PLAN (FY2002) FOR THE CAPE COD NATIONAL SEASHORE PROTOTYPE INVENTORY AND MONITORING PROGRAM

PART OF THE NORTHEAST COASTAL AND BARRIER NETWORK AND THE ATLANTIC AND GULF COAST BIOGEOGRAPHIC REGION

FY2001-FY2002

Cape Cod National Seashore Approval Signatures:

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Prepared By:

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Carrie Phillips, Inventory and Monitoring Coordinator Date

I. Overview and Objectives

Ecological Context

Cape Cod is a large glacial peninsula that extends 60 miles into the Atlantic ocean from the coast of Massachusetts. Cape Cod National Seashore (CACO) was established in 1961 and contains 44,600 acres of marine, estuarine, fresh water, and terrestrial ecosystems. Marine and estuarine ecosystems include barrier islands, beaches, spits, tidal flats, salt marshes, salt ponds, and soft-bottom benthos. Freshwater ecosystems include kettle ponds, vernal pools, sphagnum bogs, cedar swamps, and creeks. Terrestrial systems include pitch pine/scrub oak barrens, pitch pine forests, oak forests, heathlands, dunes, and sandplain grasslands. Many of these habitats are globally uncommon and the species that occupy them are correspondingly rare.

During the past three centuries Cape Cod ecosystems have been profoundly altered by human occupation. For example, construction of dikes and roadways in estuaries has changed natural tidal regimes and resulted in degradation of water quality and loss of native plant and animal species. Beach and dune stabilization efforts have interfered with natural morphological processes on shorelines. Discharges from nonpoint sources of pollution such as landfills, septic systems, and golf courses have adversely affected surface and groundwater quality. Fire suppression has altered the distribution and volume of the heathland and pitch pine communities that predominated before European settlement. Some of the highest ozone levels in the northeast have been recorded at CACO. Municipal and private in-holdings and over 5 million visitors annually create a formidable challenge to protection and management of natural resources.

Program Overview

In 1996, CACO was identified as a prototype park for long-term ecological monitoring within the Atlantic and Gulf Coast biogeographic region. As a prototype park and in partnership with U.S. Geological Survey (USGS), CACO was charged with developing and refining long-term monitoring protocols that could be of utility to other Atlantic and Gulf Coast parks, in addition to supporting management of Cape Cod's natural resources. With the advent of the network approach to inventory and monitoring, our mission expanded to include focused technical support to the Northeast and Coastal Barrier Network. Specifically, our role as a prototype park is to:

- test inventory and monitoring methods specific to the northeast coastal eco-region;
- develop long-term monitoring protocols relevant to CACO and to systems common among parks in the Network - many of these protocols will also be of use to parks in the broader biogeographic region;
- conduct studies that will help identify "vital sign" parameters for the Network and that refine, develop, or interpret the results of ecological monitoring; and
- provide technical expertise regarding inventory and monitoring techniques to the Network and parks in the broader biogeographic region.

Development of the CACO long-term ecological monitoring program has been a collaborative effort primarily between USGS and NPS. USGS has provided the bulk of the funding for development of a conceptual framework for the program and for protocol development. CACO began receiving funding specifically for the long-term monitoring program in 1997. We have used that funding to conduct inventories, to support continued collaboration with USGS on protocol development, to implement those monitoring protocols that are completed, to initiate specific studies needed to develop monitoring approaches, to publish reports, and to build the personnel and logistical capability needed to implement monitoring for the long-term.

II. Accomplishments (FY2001) and Planned Activities (FY2002)

Our FY2001 performance objectives are grouped into three general categories: monitoring and related studies, focused technical assistance to the Northeast Coastal and Barrier Network and other entities, and program management/support. In FY2002, we are adding outreach and reporting as a fourth category of performance objectives. Specific monitoring and study objectives are formulated from the ecosystem-based issue-oriented conceptual models described in *Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore*[1]. The conceptual models, and therefore our scientific objectives, are constructed around ecosystem type rather than activity type (inventory vs. monitoring vs. related study). A cross reference is provided in Appendix A to aid those interested in categorizing accomplishments and plans by activity type. To provide a broader context for the specific activities discussed for FY 2001 and FY 2002, we have also included a summary of all the monitoring protocols, inventories, and related studies being implemented, in development, or under consideration; this summary is in Appendix B and includes references for the documents cited below.

II.A. Accomplishments in FY2001

Our efforts in FY2001 focused on continuing to develop, test, and refine monitoring protocols, and to implement those protocols that have been completed. Anticipating that in future years a greater proportion of our budget will be dedicated to salaries, As we build our base of technical expertise, a greater proportion of our budget will be dedicated to salaries in future years. Therefore in FY2001, we made strategic purchases of vehicles and laboratory equipment needed for current and planned monitoring activities.

II.A.1. Monitoring and Related Studies

Ponds and Freshwater Wetlands

Objective 1 - Characterize the hydrology of the Lower Cape and support development of a hydrology monitoring protocol

Task 1.1 - Identified new well locations for a study of Lower Cape groundwater and for possible inclusion in a hydrology monitoring protocol. [Partners: USGS, Lower Cape towns]

Task 1.2 - Collected flow data from stream gauges and water level data from ponds and existing wells monthly.

Objective 2 - Monitor kettle pond water quality

Task 2.1 - Conducted annual water quality monitoring at all 20 CACO kettle ponds (from April through November) according to the kettle pond monitoring protocol (Portnoy et al. 2001).

Task 2.2 - Added five ponds to the set sampled on a biweekly basis during summer stratification to quantify the depth and duration of hypolimnetic anoxia.

Objective 3 - Develop monitoring protocols for key wildlife associated with freshwater systems

Task 3.1 - Completed year two of a three-year inventory of aquatic turtles focusing on spotted turtles (SC) and on previously unsurveyed sites in Truro and Provincetown. This inventory will be used to support development of an aquatic turtle monitoring protocol.

Task 3.2 - Provided logistical support and technical assistance to contractors field-testing methods for monitoring pond-breeding amphibians (Paton 2000). [Partners: USGS, URI].

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[1] Roman, C.T. and N.E. Barrett. 1999. Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore. USGS Patuxent Widlife Research Center, University of Rhode Island. 59p.

Estuaries and Saltmarshes

Objective 4 - Monitor saltmarsh accretion and subsidence

Task 4.1 - Measured saltmarsh sediment accretion, erosion, and relative elevation in three estuaries in spring and fall using feldspar markers and a sediment elevation table. [Partner: USGS]

Objective 5 - Monitor key estuarine wildlife

Task 5.1 - Worked collaboratively with Massachusetts Audubon's Wellfleet Bay Wildlife Sanctuary to monitor nesting terrapins.

Beaches, Barrier Islands, Spits, and Dunes

Objective 6 - Monitor beach and barrier island nesting birds

Task 6.1 - Monitored breeding population and productivity of piping plovers (FT) on CACO beaches according to the piping plover protocol. (Piping plover monitoring is not funded out of I&M but instead is funded out of resource management base funds.)

Task 6.2 - Monitored breeding populations and nesting effort of CACO's waterbird colonies according to the colonial waterbird protocol (Erwin and Cook 1999). Species monitored include roseate (FE), least (SC), common (SC), and artic (SC) terns.

Coastal Uplands

Objective 7 - Develop monitoring protocols for key upland plant communities

Task 7.1 - Completed data quality control, preliminary community change analysis, soil sampling, and part of the GIS analysis to support development of a protocol for monitoring coastal heathlands (Brosofske and Gwilliam 2001). [Partner: URI]

Task 7.2 - Completed data mining, refined modular plot technique, and re-located and re-sampled 13 of 15 of historic sampling sites to support development of a protocol for monitoring upland forest vegetation.

Objective 8 - Inventory and develop monitoring protocols for key upland wildlife

Task 8.1 - Completed testing of inventory and monitoring methods for snakes and terrestrial salamanders with particular emphasis on four-toed salamanders (SC). The results will be used to complete an inventory and develop a monitoring protocol for snakes and salamanders.

Task 8.2 - Provided logistical support and technical assistance to contractors testing point-count methods for inventorying and monitoring breeding landbirds (first year of a two-year effort) (Griffin 2000). [Partner: UMass]

Task 8.3 - Provided logistical support and technical assistance to contractors testing the utility of the MAPS protocol for monitoring avian productivity at CACO (year three of a five-year test) (DeSante and Bennett 1998). [Partners: USGS, IBP]

Task 8.4 - Executed a Cooperative Agreement to provide funding for the MAPS project in 2001 and 2002.

Task 8.5 - Completed analysis of grassland bird trend data.

Task 8.6 - Completed the second field season of a two-year inventory documenting small mammal occurrence, distribution, abundance, and habitat relationships (Bennett 1998).

Task 8.7 - Provided logistical support and technical assistance to contractors developing a protocol for monitoring canids and meso-mammals (year one of a two-year study) (O'Connell 2000). [Partner: USGS]

Multi-system/Park-wide

Objective 9 - Monitor air quality

Task 9.1 - Collected daily records of types and amounts of depositional substances [Partners: EPA, MDEP, NTN].

Task 9.2 - Established a particulate monitoring station at CACO [Partner: IMPROVE Network].

Objective 10 - Monitor precipitation
Task 10.1 - Collected precipitation data weekly at three sites.
Objective 11 - Update vegetation map and classification system
Task 11.1 - Refined a regional classification system specifically for CACO plant communities and collected data from validation plots.
Task 11.2 - Contracted for completion of photo interpretation, digitizing, and production of a final map. [Partner: UMass]
Objective 12 - Evaluate and update wildlife occurrence data
Task 12.1 - Compiled existing data on wildlife occurrence.
Objective 13 - Develop a protocol for monitoring effects of visitor use
Task 13.1 - Provided logistical support and technical assistance to contractors developing a protocol for monitoring visitor impacts to natural resources (Marion and Cahill 2000). [Partners: USGS, Virginia Tech]

II.A.2. Technical Assistance
Objective 14 - Provide technical assistance to the Northeast Coastal and Barrier Network
Task 14.1 - Provided technical staff support to Network Scoping Workshop and chaired three of the nine follow-up work groups (shoreline change, freshwater quality, contaminants).
Objective 15 - Provide technical assistance to other parks and networks in the Atlantic and Gulf Coast biogeographic region
Task 15.1 - Prepared amphibian and reptile inventory workplans for selected parks in the Northeast Temperate Network (SARA, MIMA, SAGA, SAIR) and assisted in orienting field staff and reviewing data and preliminary reports . [Partner: Wildlife Conservation Society]
Task 15.2 - Assisted the Regional I&M Coordinator by reviewing wildlife-related inventory and monitoring proposals and funding requests, and by identifying regional inventory needs and priorities.
Objective 16 - Provide technical assistance to local and regional entities
Task 16.1 - Assisted the Cape Cod Commission, the University of Massachusetts Water Resources Research Center, and local towns with Cape-wide pond sampling, volunteer training, and water quality analysis.

II.A.3. Program Management and Support
Objective 17 - Increase in-house chemical analysis capability to support water quality, soil, sediment, and vegetation studies and monitoring efforts.
Task 17.1 - Purchased an elemental analyzer, new auto-analyzer, and an infra-red gas analyzer.
Objective 18 - Secure adequate vehicles for field work and other program functions
Task 18.1 - Purchased two trucks.
Objective 19 - Provide program coordination and oversight
Task 19.1 - Hired program coordinator.
Objective 20 - Increase capacity and consistency in wildlife related field work
Task 20.1 - Hired permanent wildlife bio-tech.

II.B. FY2002 Planned Activities

In FY2002 we anticipate dedicating a significant amount of effort to protocol development and testing. As additional protocols are finalized, we will be able to increase the proportion of our effort focused on implementing completed protocols. We will also continue to provide technical support to the Northeast Coastal and Barrier Network and other parks. Recruitment and hiring will be a priority as we fill recent vacancies and continue to build our technical expertise. This

year we have also established specific outreach and reporting objectives to increase the value of our program to CACO management, the Northeast Coastal and Barrier Network, other parks, and external partners.

II.B.1. Monitoring and Related Studies

Ponds and Freshwater Wetlands

Objective 1 - Characterize the hydrology of the Lower Cape and begin long-term monitoring

Task 1.1 - Obtain archeological and other clearances for installation of new wells for the Lower Cape groundwater study, and continue to provide technical assistance as needed [Partners: USGS, Lower Cape towns]

Task 1.2 - Collect flow data from stream gauges and water level data from ponds and existing wells monthly.

Task 1.3 - Field test hydrology monitoring protocol and initiate long-term monitoring (contingent on delivery of protocol from USGS). [Partner: USGS]

Objective 2 - Monitor kettle pond water quality

Task 2.1 - Conduct annual water quality monitoring at all 20 CACO kettle ponds (from April through November) according to the kettle pond monitoring protocol (Portnoy et al. 2001).

Objective 3 - Develop monitoring protocols for key wildlife associated with freshwater systems

Task 3.1 - Complete inventory of aquatic turtles focusing on spotted turtles (SC).

Task 3.2 - Draft aquatic turtle monitoring protocol and distribute for peer review.

Estuaries and Saltmarshes

Objective 4 - Monitor saltmarsh accretion and subsidence

Task 4.1 Measure saltmarsh sediment accretion, erosion, and relative elevation in three estuaries in spring and fall using feldspar markers and a sediment elevation table. [Partner: USGS]

Objective 5 - Incorporate tidal systems in hydrology monitoring

Task 5.1 - Develop and test methods for gauging flow in tidally influenced creeks that have restricted flow due to culverts and tide gates. [Partner: USGS]

Objective 6 - Begin long-term monitoring of saltmarsh vegetation

Task 6.1 - Field test saltmarsh vegetation monitoring protocol and initiate long-term data collection (contingent on delivery of protocol by USGS). [Partner: USGS]

Objective 7 - Begin long-term monitoring of estuarine nekton

Task 7.1 - Field test estuarine nekton monitoring protocol and initiate long-term data collection (contingent on delivery of protocol by USGS). [Partner: USGS]

Objective 8 - Monitor key estuarine wildlife

Task 8.1 - Work collaboratively with Massachusetts Audubon's Wellfleet Bay Wildlife Sanctuary to monitor nesting terrapins.

Beaches, Barrier Islands, Spits, and Dunes

Objective 9 - Monitor beach and barrier island nesting birds

Task 9.1 - Monitor breeding population and productivity of piping plovers (FT) on CACO beaches according to the piping plover protocol. (Piping plover monitoring is not funded out of I&M but instead is funded out of resource management base funds.)

Task 9.2 - Monitor breeding populations and nesting effort of CACO's waterbird colonies according to the colonial waterbird protocol (Erwin and Cook 1999). Species monitored include roseate (FE), least (SC), common (SC), and arctic (SC) terns.

Objective 10 - Begin long-term monitoring of geomorphic shoreline change

Task10.1 - Field test geomorphic shoreline change protocol and initiate long-term data collection (contingent on delivery of protocol by USGS). [Partner: USGS]

Coastal Uplands

Objective 11 - Develop monitoring protocols for key upland plant communities

Task 11.1 - Continue community change analysis, soil sampling, and GIS analysis to support development of a protocol for monitoring coastal heathlands (Brosofske and Gwilliam 2001). [Partner: URI]

Task 11.2 - Re-locate and re-sample remaining historic sampling sites, establish and sample 15 new sites, and complete draft of upland forest vegetation monitoring protocol.

Objective 12 - Inventory and develop monitoring protocols for key upland wildlife

Task 12.1 - Complete snake and terrestrial salamander inventory.

Task 12.2 - Provide logistical support and technical assistance to contractors testing point-count methods for monitoring breeding landbirds (will be year two of a two-year field effort) (Griffin 2000). [Partner: UMass]

Task 12.3 - Provide logistical support and technical assistance to contractors testing the utility of the MAPS protocol for monitoring avian productivity at CACO (will be year four of a five-year test) (DeSante and Bennett 1998). [Partners: USGS, IBP]

Task 12.4 - Modify the current Cooperative Agreement to provide funding for the last year (2003) of the MAPS project

Task 12.5 - Analyze small mammal field data from 2000 and 2001, and revise the existing protocol accordingly.

Task 12.6 - Provide logistical support and technical assistance to contractors developing a protocol for monitoring canids and meso-mammals (will be year two of a two-year study) (O'Connell 2000). [Partner: USGS]

Multi-system/Park-wide Monitoring

Objective 13 - Monitor air quality

Task 13.1 - Collect daily records of types and amounts of depositional substances [Partners: EPA, MDEP, NTN].

Task 13.2 - Monitor particulates using the IMPROVE station [Partner: IMPROVE Network].

Objective 14 - Monitor precipitation

Task 14.1 - Collect precipitation data weekly at three sites.

Objective 15 - Update vegetation map and classification system

Task 15.1 - Provide technical assistance to contractor to complete vegetation map. [Partner: UMass]

Objective 16 - Develop a protocol for monitoring effects of visitor use

Task 16.1 - Field test methods for monitoring visitor impacts to natural resources (Marion and Cahill 2000). [Partners: USGS, Virginia Tech]

II.B.2. Outreach and Reporting

Objective 17 - Provide information to non-technical audiences

Task 17.1 - Conduct a training session with staff from the Interpretation and Cultural Resources Division prior to the 2002 season.

Task 17.2 - Finalize the format for the new CACO Natural Resources Fact Sheet; produce and distribute at least two fact sheets addressing I&M projects.

Task 17.3 - Produce "Frequently Asked Questions" supplement to the Kettle Pond Data Atlas (Portnoy et al 2001)

Objective 18 - Provide technical information to NPS audiences and other institutions (park management, the Northeast and Coastal Barrier Network, other interested parks, WASO, partners)

Task 18.1 - Develop proposal for a two-day conference on the CACO I&M program and submit for Departmental approval (target date for conference is November 2002); complete planning and

contracting for the conference if Departmental approval is received by January of 2002 [Partner: USGS]
Task 18.2 - Submit two articles on CACO I&M projects to Park Science.
Objective 19 - Document findings and activities
Task 19.1 - Draft annual plover monitoring report for the 2002 nesting season. (Piping plover monitoring is not funded out of I&M but instead is funded out of resource management base funds.)
Task 19.2 - Complete annual administrative report for 2001 and work plan for 2002.
[See also Tasks 3.2, 11.2, and 12.5 regarding drafting monitoring protocols for aquatic turtles and upland forest vegetation, and revising the protocol for small mammal monitoring.]

II.B.3. Technical Assistance
Objective 20 - Provide technical assistance to the Northeast Coastal and Barrier Network
Task 20.1 - Prepare amphibian and reptile inventory workplans for selected network parks (SAHI, FIIS, WIFL, GATE), and assist in orienting field staff and reviewing data and preliminary reports. [Partner: Wildlife Conservation Society]
Task 20,.2 - Serve as the technical advisor for the network contaminants monitoring contract.
Objective 21 - Provide technical assistance to other parks and networks in the Atlantic and Gulf Coast biogeographic region
Task 21.1 - Assist Regional I&M coordinator by reviewing wildlife-related inventory and monitoring proposals and funding requests, and by identifying regional inventory needs and priorities.
Objective 22 - Provide technical assistance to local and regional entities
Task 22.1 - Assist the Cape Cod Commission, the University of Massachusetts Water Resources Research Center, and local towns with Cape-wide pond sampling, volunteer training, and water quality analysis.
Task 22.2 - Pursue partnership with citizens' water quality monitoring effort for water sample analysis services.

II.B.4. Program Management
Objective 23 - Replace lost technical expertise
Task 23.1 - Fill vacant plant ecologist position
Task 23.2 - Fill vacant physical scientist position
Objective 24 - Develop and maintain an integrated data management system
Task 24.1 - Hire a data manager
Task 24.2 - Produce preliminary draft data management plan
Objective 25 - Secure adequate work force to complete scheduled field and laboratory tasks
Task 25.1 - Hire a laboratory technician to increase analytical capacity, particularly water quality analysis.
Task 25.2 - Hire an aquatic ecology bio-tech for freshwater and estuary monitoring activities.
Task 25.3 - Hire two seasonal bio-techs for wildlife and vegetation monitoring activities.
Task 25.4 - Recruit four Student Conservation Association volunteers to assist with pond water quality, wildlife, and vegetation monitoring.
Objective 26 - Increase program efficiency and coordination
Task 26.1 - Develop five-year staffing and budget plan.
Task 26.2 - Update, centralize, and as necessary, develop additional Standard Operating Procedures for program management and administration.

III. Staffing

Carrie Phillips, Cape Cod National Seashore I&M Coordinator
Data Manager, TBA
Bob Cook, Wildlife Biologist
Kelly Boland, Wildlife Bio-Tech
Seasonal Wildlife Bio-Tech, TBA
Evan Gwilliam, Aquatic Ecologist (SCEP)
Aquatic Ecology Bio-Tech, TBA
Physical Scientist, TBA
Plant Ecologist, TBA
Seasonal Vegetation Bio-Tech, TBA
Lab Technician, TBA

Many critical I&M functions are also carried out by Natural Resource Division staff in non-I&M positions. These functions include oversight by the Chief of Natural Resources, budget and personnel, GIS support, laboratory analysis, technical expertise, and several inventory and monitoring projects such as piping plover, colonial waterbirds, kettle pond water quality, and the vegetation map.

IV. Public Interest Highlights

Staff at Cape Cod National Seashore and the Northeast Support Office have conducted water quality monitoring of the Seashore's 20 kettle ponds since the mid-1970s. Prior to the inception of the Prototype Inventory and Monitoring Program, staff did their best to cobble the effort together on a year-to-year basis with, unfortunately, some important gaps in the data record. This all changed with incorporation of the pond program into the emerging I&M prototype program in 1998. The new I&M funding supports field data collection, sampling and analytical equipment and, perhaps most significantly, data synthesis and interpretation by Park scientific staff, resulting most recently (2001) in the publication of a semi-technical *Kettle Pond Data Atlas: Paleoecology and Modern Water Quality*. This publication has been very well received and is generating new public and management awareness of pond preservation issues in the face of greatly increased human use. Over 300 copies of The Atlas have been distributed and 80 more have been requested. The Atlas is now in its second printing with a supplement of 75 frequently asked questions and a glossary.

V. Reports, Publications, and Presentations

<u>Reports and Publications</u>:

DeSante, D.F., N. Michel, and D.R. O'Grady. 2001. The 2000 annual report of the MAPS program in Cape Cod National Seashore. The Institute for Bird Populations, Point Reyes Station, CA. 45pp.

Erwin, R.M. C. Conway, and S. Hadden. (submitted). Assessing the status of marsh birds at Cape Cod National Seashore, Massachusetts: Methods for Monitoring. Submitted to Northeast Naturalist.

Hadden, S. W. 2001. Waterbird inventory and monitoring: report on protocol implementation and development at Cape Cod National Seashore. Cape Cod National Seashore, Wellfleet, MA. 66 pp.

Hake, M. and E.G. Schneider. 2001. Monitoring and managing of piping plovers and colonial waterbirds at Cape Cod National Seashore. CACO files. 47pp. (Piping plover monitoring is not funded out of I&M but instead is funded out of resource management base funds.)

Kearney, S. and Cook, R. P. (in press). Status of grassland and heathland birds at Cape Cod National Seashore, Massachusetts. NPS BOSO Technical Report . 31 pp.

Portnoy, J.W., M.G. Winkler, P.R. Sanford, and C.N. Farris. 2001. Kettle Pond Data Atlas: Paleoecology and modern water quality. Cape Cod National Seashore, National Park Service, U.S. Department of Interior. 119pp.

Poster Presentation:
Hubbard, J.A., J.W. Portnoy, C.T. Roman, N.E. Barrett, and E.L. Gwilliam. 2001. Effects of drought on community dynamics of vernal wetlands on Cape Cod. Poster Presentation at the Society for Conservation Biology 2001 Annual Meeting.

VI. Support to the Northeast Coastal and Barrier Network

In FY2001, we supported the Northeast Coastal and Barrier Network by assisting with scoping, providing technical leadership to specific work groups, and providing technical review of proposals and reports. In FY2002, we will continue to provide technical assistance to the Network and the Regional I&M Coordinator, and will develop workplans for amphibian and reptile inventories. We will also accomplish most of the planning necessary to stage a technical workshop in the fall of 2002. Our accomplishments in 2001 and plans for 2002 are specifically described in sections IIA 13.1 and 14.2 and IIB 16.1, 18.1, and 19.1.

VII. Budget

In FY2001 our budget consisted of the $513,000 in CACO's base funds directed specifically to inventory and monitoring and a $189,000 add-on received annually from WASO. We expect this level of funding to continue in FY2002. Not reflected in these amounts, nor in the budget sheets that follow, is the $205,000 expended by USGS for protocol development; many of the developing protocols identified in the work plan and Appendix B are contracted by USGS. Similarly, amphibian and land bird point-count work contracted by CACO with FY2000 funds is ongoing but is not described in detail in these budget sheets. The contracts for these projects totaled $90,000 in FY2000; in FY2001 we expended funds for logistical support, housing, and vehicles for these projects and will continue to do so for the land bird point-count work in FY2002. Also not reflected is the significant staff time from non-I&M positions that contributes to I&M objectives. In FY2002 and beyond, we will track this time and report it as "CACO Resource Management Base" to better account for CACO's support of this program. In FY2001, salaries, specialized equipment, and vehicles accounted for over 80% of I&M base funds. In FY2002, a greater proportion of our base funding will support salaries as we build our technical expertise and refill key vacancies. Supplies and miscellaneous expenses accounted for significant funds in FY2001 and are projected to do the same in FY2002. This broad category of expenditures includes field equipment, computers, housing for contractors and other visiting scientists, office furniture and supplies, and other recurring expenses. In FY2002, we will develop and track this spending by subcategories to more fully describe these expenditures.

Budget Summary - Cape Cod National Seashore
Prototype Inventory & Monitoring Program
FY 2001 Income and Expenditures

	CACO I&M Base (NZI)	WASO Project Funding (NII)
Funding Sources		
Servicewide I&M Program	513,000	189,000
Total Income	$513,000	$189,000
FY01 Expenditures		
I&M Personnel (salary and benefits)		
Coordinator	27,767	
Wildlife Biologist	74,894	
Wildlife Bio-Tech	12,719	
Aquatic Ecologist (SCEP)	17,129	
Physical Scientist	53,896	
Physical Science Bio-Tech	32,299	
Plant Ecologist	61,762	
GIS Specialist (SCEP)	23,960	
Seasonal Bio-Techs (6)	47,942	
Budget/Clerical Assistant	21,176	
Volunteers		
Student Conservation Association - 6 volunteers	7,018	17,586
Student Conservation Association - Housing	7,681	
Contracts and Cooperative Agreements		
Vegetation Map - UMass		35,000
Avian productivity monitoring - IBP		40,000
Operations and Equipment		
Elemental analyzer		29,790
Infra-red gas analyzer		15,615
Auto-analyzer	27,738	
Vehicle purchase - 2 trucks	19,128	23,901
Vehicle lease - GSA	7,695	453
Trailer rental for temporary office space	4,085	
Supplies and miscellaneous expenses	41,768	20,978
Travel		
Travel and training	9,497	5,857
Other		
Shipping (including 2 PCS moves)	14,846	
Total Expenditures	$513,000	$189,180

Budget Summary - Cape Cod National Seashore
Prototype Inventory & Monitoring Program
Proposed FY 2002 Income and Expenditures

	CACO I&M Base (NZI)	WASO Project Funding (NII)
Funding Sources		
Servicewide I&M Program	513,000	189,000
Total Income	$513,000	$189,000
FY02 Expenditures		
I&M Personnel (salary and benefits)		
Coordinator	84,654	
Data Manager	45,015	
Wildlife Biologist	78,682	
Wildlife Bio-Tech	34,011	
Plant Ecologist	45,396	
Physical Scientist	34,305	
Aquatic Ecologist (SCEP)	38,163	
Aquatic Ecologist Bio-Tech	16,504	
Lab Tech	15,929	
Seasonal Bio-Techs (2)	28,530	
Budget/Clerical Assistant	21,811	.
Volunteers		
Student Conservation Association - 4 volunteers		10,000
Student Conservation Association - Housing		3,200
Contracts and Cooperative Agreements		
Avian productivity monitoring - IBP		26,000
Other inventory and monitoring contracts		75,000
Operations and Equipment		
Trailer rental for temporary office space		5,000
Supplies and miscellaneous expenses		39,800
Travel		
Travel and training		30,000
Other		
PCS Moves (3)	70,000	
Total Expenditures	$513,000	$189,000

Appendix A - FY2001 accomplishments and FY2002 planned tasks by activity type

The following two tables are provided to aid reviewers interested in categorizing activities as either inventory, monitoring, or an integration of inventory and monitoring. The table on the left lists activities in the order they appear in the annual report and work plan. The table on the right re-organizes these same activities so that all the inventory, monitoring, and integrated activities are grouped together.

FY2001 Accomplishments

I = accomplishments that wholly or predominantly relate to inventories
M = accomplishments that wholly or predominantly relate to monitoring
I&M = accomplishments that more or less pertain to inventories and monitoring equally

Task	Activity Type
1.1 new wells	M
1.2 flow/water level	M
2.1 water quality	M
2.2 pond stratification	M
3.1 aquatic turtles	I&M
3.2 amphibians	M
4.1 marsh sediment elevation	M
5.1 terrapins	M
6.1 piping plovers	M
6.2 colonial waterbirds	M
7.1 heathlands	M
7.2 upland forest	M
8.1 snakes/salamanders	I&M
8.2 landbird point counts	I&M
8.3 avian productivity	M
8.4 avian productivity - fund 01 & 02	M
8.5 grassland birds	M
8.6 small mammals	I&M
8.7 canids/meso-mammals	M
9.1 atmospheric deposition	M
9.2 atmospheric particulates	M
10.1 precipitation	M
11.1 vegetation classification	I
11.2 vegetation map	I
12.1 wildlife data compilation	I
13.1 visitor impacts	M
14.1 network support	I&M
15.1 inventory work plans	I
15.2 tech. asst. to regional coord.	I&M
16.1 tech. asst. to other partners	M
17.1 chemical analysis equipment	M
18.1 vehicles	I&M
19.1 program coordinator	I&M
20.1 permanent wildlife bio-tech	I&M

Task	Activity Type
11.1 vegetation classification	I
11.2 vegetation map	I
12.1 wildlife data compilation	I
15.1 inventory work plans	I
3.1 aquatic turtles	I&M
8.1 snakes/salamanders	I&M
8.2 landbird point counts	I&M
8.6 small mammals	I&M
14.1 network support	I&M
15.2 tech. asst. to regional coord.	I&M
18.1 vehicles	I&M
19.1 program coordinator	I&M
20.1 permanent wildlife bio-tech	I&M
1.1 new wells	M
1.2 flow/water level	M
2.1 water quality	M
2.2 pond stratification	M
3.2 amphibians	M
4.1 marsh sediment elevation	M
5.1 terrapins	M
6.1 piping plovers	M
6.2 colonial waterbirds	M
7.1 heathlands	M
7.2 upland forest	M
8.3 avian productivity	M
8.4 avian productivity - fund 01 & 02	M
8.5 grassland birds	M
8.7 canids/meso-mammals	M
9.1 atmospheric deposition	M
9.2 atmospheric particulates	M
10.1 precipitation	M
13.1 visitor impacts	M
16.1 tech. asst. to other partners	M
17.1 chemical analysis equipment	M

FY2002 Planned Tasks

I = tasks that wholly or predominantly relate to inventories

M = tasks that wholly or predominantly relate to monitoring

I&M = tasks that more or less pertain to inventories and monitoring equally

Task	Activity Type
1.1 new wells	M
1.2 flow/water level	M
1.3 test hydrology protocol	M
2.1 water quality	M
3.1 aquatic turtles	I&M
3.2 aquatic turtle protocol draft	M
4.1 marsh sediment elevation	M
5.1 tidal creek hydrology	M
6.1 test salt marsh veg. protocol	M
7.1 test estuarine nekton protocol	M
8.1 terrapins	M
9.1 piping plovers	M
9.2 colonial waterbirds	M
10.1 test shoreline change protocol	M
11.1 heathlands	M
11.2 upland forest	M
12.1 snakes/salamanders	I&M
12.2 landbird point counts	I&M
12.3 avian productivity	M
12.4 avian productivity - fund for 03	M
12.5 small mammals	I&M
12.6 canids/meso-mammals	M
13.1 atmospheric deposition	M
13.2 atmospheric particulates	M
14.1 precipitation	M
15.1 vegetation map	I
16.1 visitor impacts	M
17.1 train interpreters	I&M
17.2 fact sheets	I&M
17.3 Pond Atlas FAQs	I&M
18.1 conference proposal	I&M
18.2 Park Science articles	I&M
19.1 plover report	M
19.2 administrative report	I&M
20.1 inventory workplans	I
20.2 contaminants technical advisor	I&M
21.1 tech. asst. to regional coord.	I&M
22.1 tech. asst. to other partners	M
22.2 water quality partnership	M
23.1 plant ecologist	I&M
23.2 physical scientist	I&M
24.1 data manager	I&M
24.2 data management plan	I&M
25.1 lab tech	M
25.2 aquatic ecology bio-tech	I&M
25.3 seasonal bio-techs	I&M
25.4 SCAs	I&M
26.1 staffing/budget plan	I&M
26.2 SOPs	I&M

Task	Activity Type
15.1 vegetation map	I
20.1 inventory workplans	I
3.1 aquatic turtles	I&M
12.1 snakes/salamanders	I&M
12.2 landbird point counts	I&M
12.5 small mammals	I&M
17.1 train interpreters	I&M
17.2 fact sheets	I&M
17.3 Pond Atlas FAQs	I&M
18.1 conference proposal	I&M
18.2 Park Science articles	I&M
19.2 administrative report	I&M
20.2 contaminants technical advisor	I&M
21.1 tech. asst. to regional coord.	I&M
23.1 plant ecologist	I&M
23.2 physical scientist	I&M
24.1 data manager	I&M
24.2 data management plan	I&M
25.2 aquatic ecology bio-tech	I&M
25.3 seasonal bio-techs	I&M
25.4 SCAs	I&M
26.1 staffing/budget plan	I&M
26.2 SOPs	I&M
1.1 new wells	M
1.2 flow/water level	M
1.3 test hydrology protocol	M
2.1 water quality	M
3.2 aquatic turtle protocol draft	M
4.1 marsh sediment elevation	M
5.1 tidal creek hydrology	M
6.1 test salt marsh veg. protocol	M
7.1 test estuarine nekton protocol	M
8.1 terrapins	M
9.1 piping plovers	M
9.2 colonial waterbirds	M
10.1 test shoreline change protocol	M
11.1 heathlands	M
11.2 upland forest	M
12.3 avian productivity	M
12.4 avian productivity - fund for 03	M
12.6 canids/meso-mammals	M
13.1 atmospheric deposition	M
13.2 atmospheric particulates	M
14.1 precipitation	M
16.1 visitor impacts	M
19.1 plover report	M
22.1 tech. asst. to other partners	M
22.2 water quality partnership	M
25.1 lab tech	M

Appendix B - Protocol/Study Summaries

Protocol/Study Name	Status	Reference	Description
Amphibians	In Development	Paton, P. 2000. Development of protocols for long-term amphibian monitoring at Cape Cod National Seashore. CACO Files, 19pp.	Amphibians in vernal and permanent ponds are monitored using various methods, each aimed at specific life stages. Methods include anuran call counts, egg mass counts, minnow traps, and dip net counts.
Aquatic Invertebrates	Under Consideration		We are considering developing a protocol for monitoring freshwater and estuarine invertebrate communities as an index of biological integrity.
Beach Macroinvertebrates	In Development	Ginsburg, H. and J. Kluft. Undated. Monitoring the beach macroinvertebrate fauna at Cape Cod National Seashore: assessment of community dynamics. CACO Files. 8pp.	Methods will be developed to monitor the beach macroinvertebrate community. Beach wrack density, proximity of beach wrack to dune vegetation, and beach stability will also be examined.
Canids/Meso-Mammals	In Development	O'Connell, A. 2000. Population Estimates, Distribution, Movements, and Feeding Ecology of Red Foxes (Vulpes vulpes) on Cape Cod, Massachusetts. CACO Files, 14pp.	The use of motion activated cameras, hair traps, and tracking plates for monitoring population trends in Canids and other meso-mammals are being field tested.
Dune Grassland Vegetation	In Development	Barrett, N. 1999. Proposed sampling protocols to be tested for a vegetation monitoring program at Cape Cod National Seashore. CACO Files	This protocol will monitor species composition and cover of beach grass (Ammophila brevigulata) dominated grasslands.
Dune Slack Wetland Vegetation	In Development	Hubbard, J.A., 2001. Water Resource Division Grant Proposal (2002-2003). CACO Files	This study will characterize deflation plain wetlands and examine plant water strees. This study will expand our understanding of the effects of municipal water withdrawal and help identify key parameters to montor long term effects.
Estuarine Nekton	In Peer Review	Raposa, K. and C. Roman. 2001. Monitoring Nekton in Shallow Estuarine Habitats: A Protocol for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. CACO	This protocol will track long-term changes and responses to restoration in shallow (<1m) estuarine habitats. Throw traps will be used during early and late summer sampling periods at 1 to 3 year intervals. Eelgrass (Zostera marina) and saltmarsh habitats are emphasized.

Protocol/Study Name	Status	Reference	Description
Estuarine Nutrient Enrichment	In Development	Roman, C., B. Nowicki, and E. Kinney. 1998. Design and testing of a sampling protocol for monitoring estuarine water quality. CACO Files. 22pp.	Methods will be developed to monitor terrestrial and atmospheric nitrogen loading and the responses of primary producers.
Freshwater Fish	In Development	Mather, M. 1998. Patterns and processes for freshwater fish distribution in northeastern National Parks: inventory, monitoring, and a model of governing processes. CACO Files. 22pp.	This project will inventory freshwater fish in several northeastern parks and will develop methods for long-term monitoring. In CACO, the study will address fish associated with kettle ponds, inter-dune ponds, a former tidal system that is now predominantly fresh, and two creeks. Information regarding food base and physical characteristics of each system will also be collected.
Geomorphic Shoreline Change	In Development	Allen, J., P. August, and J. Haines. 1997. Shoreline Change: Cape Cod National Seashore Inventory and Monitoring Program. CACO Files. 12pp.	A protocol will be developed to monitor trends in shoreline change using LIDAR, remote video, and GPS.
Groundwater Quality	Under Consideration		We are considering monitoring groundwater quality to compliment our hydrology and surface water quality monitoring efforts.
Heathland Vegetation	In Development	Brosofske, K. and E. Gwilliam. 2001. Developing a Coastal Heathland Monitoring Protocol for the Cape Cod National Seashore. CACO Files. 7pp.	A protocol will be developed to monitor changes in the extent and floristic composition of coastal heathlands.
Hydrology	In Development	Weiskel, P. and T. Cambareri. 1998. Development of Protocols for Long-Term Hydrological Monitoring at the Cape Cod National Seashore. CACO Files.	This protocol will address surface- and groundwater hydrology. Surface waters to be monitored include ponds, wetlands, and streams.
Kettle Pond Vegetation	In Development	Roman, C.T., Barrett, N.E., and Portnoy, J.W. 2001. Aquatic vegetation and trophic condition of Cape Cod (Massachusetts, U.S.A.) kettle ponds. Hydrobiologica 443:31-42.	Plant cover data from permanent plots collected in 1997 & 1999 are being analyzed and evaluated in 2001.
Landbirds-MAPS	In Development	DeSante, D.F. and Bennett, A. 1998. Monitoring Avian Productivity and Survivorship (MAPS) in Cape Cod National Seashore.	Demographic approach to avian monitoring employs mist netting and banding to evaluate population size, annual productivity and inter-annual survival. Monitoring at CACO is conducted in three habitats (oak forest, pitch pine forest, pitch pine scrub) and at sites adjacent to low and high residential density.
Landbirds-Point Counts	In Development	Griffin, C. 2000. Inventory and Development of Monitoring Protocols for Landbird Communities at Cape Cod National Seashore. CACO Files. 10 pp.	Variable circular plot counts are being used to monitor the distribution, abundance, and habitat association of landbirds at CACO.

Protocol/Study Name	Status	Reference	Description
Marsh Sedimentation and Sea Level	In Development		Sediment elevation tables and feldspar markers are being used to monitor sediment accretion, erosion, and sea level change.
Meteorological and Atmospheric Monitoring	In Development	USGS Patuxent Wildlife Research Center. 2001. Draft: Meteorological and atmospheric monitoring: A protocol for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore.	This document identifies and describes all of the meteorological and atmospheric data that are currently being collected by CACO and cooperating agencies. CACO is a NADP and IMPROVE site. A protocol for tracking and analyzing appropriate parameters over time has yet to be developed.
Pond Water Quality	Completed	Portnoy, J., J. Cote, and K. Lee. 2001. Water Quality Monitoring Protocol for Kettle Ponds of Cape Cod National Seashore. CACO Files. 54pp.	Kettle pond water quality is monitored spring through fall. Parameters measured include total phosphorous, total nitrogen, nitrate, ammonium, chlorophyll a, major ions, and pH. Depth profiles (temperature, conductivity, pH, Eh, dissolved oxygen) are measured in early spring and late
Reptiles	In Development		The use of a number of methods (coverboards, traps) for monitoring selected reptile species is being evaluated.
Salt Marsh Vegetation	In Peer Review	Roman, C.T. and M.J. James-Pirri 2001. Monitoring Salt Marsh Vegetation: A Protocol for the Long-Term Ecosystem Monitoring Program at Cape Cod National Seashore. CACO Files	This protocol is designed to track changes associated with saltmarsh restoration as well as to detect long-term changes. Permanent plots will be sampled using the point intercept method in late summer or early fall. The protocol uses a randomized sampling design with systematic placement of permanent quadrats.
Sediment/Benthic Contaminants	In Development	Quinn, J. and J. King. 1999. The Study of Anthropogenic Hydrocarbons in Coastal Ponds and Harbors in the Cape Cod National Seashore. CACO Files. 8pp.	This study examines total petroleum hydrocarbons and polycyclic aromatic hydrocarbons in sediments and blue mussels (Mytilus edulis). The objective is to establish a baseline for organic contaminants in CACO ponds and estuaries.
Small Mammals	In Development	Bennett, A. 1998. Protocol for sampling small mammals at Cape Cod National Seashore. CACO Files.	Protocol employs mark and recapture sampling in five major habitats (2 sites per habitat) to estimate population size, density, survival, and recruitment.
Soil Nutrient Monitoring	Under Consideration		We are considering developing a protocol that will complement vegetation monitoring protocols for each major terrestrial ecosystem at CACO. The intention is to provide an ecosystem perspective on vegetation dynamics and succession.

Protocol/Study Name	Status	Reference	Description
Upland Forest Vegetation	In Development	Barrett, N. 1999. Proposed sampling protocols to be tested for a vegetation monitoring program at Cape Cod National Seashore. CACO Files	A refined protocol is being tested in 2001-2002 on 15 existing (2001) and 15 new sites. Parameters measured include plant cover by strata (herbaceous, shrub, and canopy), with characterization of associated soil characteristics (texture, nutrients, stable isotopes).
Vegetation Map	In Development		The distribution and areal extent of cover types was mapped in 1991 and will be re-mapped in 2001 and once every ten years thereafter. For the 2001 and future mapping efforts, validation plots will be used to support photo interpretation. A regional classification system will be used.
Vernal Wetland Vegetation	In Development	Barrett, N. 1999. Proposed sampling protocols to be tested for a vegetation monitoring program at Cape Cod National Seashore. CACO Files	Plant cover data from permanent plots collected in 1997 & 1999 are being analyzed and evaluated in 2001. A scientific publication documenting these results is being prepared in 2001.
Visitor Use and Resource Impact	In Development	Marion, J. and K. Cahill. 2000. Design and Testing of a Sampling Protocol for Monitoring Visitor Use and Resource Impact. CACO Files, 16 pp.	Methods are being developed to track visitor activities most likely to affect natural resources. Issues of concern include disturbance of nesting and migrating birds on CACO's beaches, degradation of kettle pond vegetation and water quality, and trail proliferation through sensitive vegetation, particularly American beach grass (Ammophila
Waterbirds-Colonial Waterbirds	In Development	Erwin, M. and Cook, R.P. 1999. Waterbird Monitoring Protocol, Cape Cod National Seashore. CACO Files, 51 pp.	Transect counts are used to estimate number of nesting pairs at waterbird colonies throughout CACO.
Waterbirds-Marsh Birds	In Development	Erwin, M. and Cook, R.P. 1999. Waterbird Monitoring Protocol, Cape Cod National Seashore. CACO Files, 51 pp.	Tape playbacks of target species (rails, coots, gallinules, and bitterns) from established sampling points are used monitor the distribution and abundance of these species at selected wetland sites.
Waterbirds-Piping Plover	Completed	Erwin, M. and Cook, R.P. 1999. Waterbird Monitoring Protocol, Cape Cod National Seashore. CACO Files, 51 pp.	USFWS protocols for monitoring nesting piping plover are followed. Numbers of nesting pairs, nesting attempts, nesting success, fledging success are monitored at nesting beaches throughout CACO.

Protocol/Study Name	Status	Reference	Description
Waterbirds-Shorebirds	In Development	Erwin, M. and Cook, R.P. 1999. Waterbird Monitoring Protocol, Cape Cod National Seashore. CACO Files, 51 pp.	The distribution, abundance, and species composition of flocks of waterbirds (includes sandpipers, plovers, gulls, terns, waterfowl) is monitored over the course of the fall migration (July to November) at selected sites in park. Sites are partitioned into smaller areas, and all birds counted. Counts are conducted at low tide and high tide.